saúde EM DEBATE

ORIGINAL ARTICLE

The accuracy of the Adapted Brazilian Functionality Index in assessing disability severity

Acurácia do Índice de Funcionalidade Brasileiro Adaptado na avaliação da gravidade da deficiência

Exactitud del Índice de Funcionalidad Brasileño Adaptado para evaluar la gravedad de la discapacidad

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ABSTRACT This article describes accuracy measurements against a reference scale from the Brazilian project to validate the Brazilian Functionality Index Applied for Retirement Purposes (IFBRA) for authorizing eligibility for early retirement. The IFBRA assesses the functionality of Persons with Disabilities (PwDs) by combining the International Classification of Functioning, Disability and Health, the Functional Independence Measure, and performance and barriers to classify severity levels. It represents the third phase of a nationwide validation study. Accuracy was derived from a census survey of spontaneous demand to determine eligibility for early retirement and assessed sensitivity, specificity, and effectiveness compared to the standard scale constructed for this study. The nationwide survey assessed the best agreement between physicians' and social workers' assessments of disability severity of insured PwDs workers. Maximum effectiveness and performance with sensitivity and specificity of 85% occurred when we combined the two professional raters' sum scores with cutoff points at respective percentiles and absolute values of the evaluator pairs at 20% – 6,060, 43% – 6,750, and 84% – 7,750. The IFBRA demonstrated high accuracy, validity, and effectiveness according to the reference standard.

KEYWORDS Disability evaluation. Validation studies. Reproducibility of results. Social welfare. Retirement.

RESUMO *Este artigo descreve medidas de acurácia comparadas a uma escala de referência do projeto brasileiro de validação do Índice de Funcionalidade Brasileiro Aplicado para Fins de Aposentadoria (IFBRA), para autorizar a elegibilidade à aposentadoria antecipada de Pessoas com Deficiência (PcD). Avalia a funcionalidade combinando a Classificação Internacional de Funcionalidade, Incapacidade e Saúde, a Medida de Independência Funcional, o desempenho e as barreiras para classificar níveis de gravidade. Representa a terceira fase de um estudo de validação nacional. A acurácia derivou de um levantamento censitário de demanda espontânea para determinar a elegibilidade à aposentadoria antecipada e avaliou sensibilidade, especificidade e eficácia comparadas à escala padrão construída para este estudo. O levantamento nacional avaliou a melhor concordância entre as avaliações de médicos e assistentes sociais sobre a gravidade da deficiência de trabalhadores PcD segurados. A eficácia e o desempenho máximos, com sensibilidade e especificidade de 85%, ocorreram quando se combinaram as pontuações dos dois avaliadores profissionais com os pontos de corte nos respectivos percentis e valores absolutos dos pares de avaliadores em 20% – 6.060, 43% – 6.750 e 84% – 7.750. O IFBRA demonstrou alta precisão, validade e eficácia de acordo com o padrão de referência.*

PALAVRAS-CHAVE *Avaliação da deficiência. Estudos de validação. Reprodutibilidade dos testes. Seguridade social. Aposentadoria.*

RESUMEN *Este artículo describe medidas de exactitud comparadas con la escala de referencia del proyecto de validación brasileño del Índice Funcional Brasileño Aplicado a Fines de Jubilación (IFBRA), para la elegibilidad a la jubilación anticipada de personas con discapacidad. Evalúa la funcionalidad combinando la Clasificación Internacional del Funcionamiento, de la Discapacidad y de la Salud, la Medida de Independencia Funcional, el desempeño y las barreras para clasificar los niveles de gravedad. Representa la tercera fase de la validación nacional. La exactitud se derivó del censo de demanda espontánea para la elegibilidad, evaluando sensibilidad, especificidad y efectividad comparadas con la escala estándar construida para este estudio. La encuesta nacional evaluó la concordancia entre médicos y trabajadores sociales con respecto a la gravedad de la discapacidad de los trabajadores asegurados. La máxima eficacia y rendimiento, con una sensibilidad y especificidad del 85 %, se obtuvieron combinando las puntuaciones de los dos evaluadores profesionales con los puntos de corte correspondientes a los percentiles y valores absolutos de cada par de evaluadores: 20 % – 6,060, 43 % – 6,750 y 84 % – 7,750. El IFBRA demostró alta precisión, validez y eficacia conforme al estándar de referencia.*

PALABRAS CLAVE *Evaluación de la discapacidad. Estudios de validación. Reproducibilidad de los resultados. Bienestar social. Jubilación.*

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Introduction

The Brazilian Constitution establishes universal, equal rights, regardless of ability or disability. However, Persons with Disabilities (PwDs) still struggle to enter and remain in the labor market[1-3].

The 2022 Brazilian census, released two years later, showed that of the country's 198.3 million inhabitants, 14.4 million (7.3%) were PwDs, of whom 403,255 were formal workers and insured contributors to the Brazilian public Social Security[4,5]. In 2013, the Brazilian National Congress enacted Complementary Law (LC) No. 142[6] to promote the United Nations Convention on the Rights of Persons with Disabilities (CRPD), which Brazil ratified in 2007[7]. Under this law, working PwDs have the right to retire early for a fraction of the regular contribution period. In addition, the National Institute of Social Security (INSS) is tasked with conducting a disability assessment to assess the eligibility of PwDs for early retirement[6,8,9].

The Institute for the Study of Labor and Society (IETS), a non-governmental organization, produced the Brazilian Functional Index (IFBR), an instrument developed to measure and classify the type and intensity of disability in PwDs[10,11]. The original version of the IFBR was then adapted and, in 2013, it was renamed the Brazilian Functionality Index Applied for Retirement Purposes (IFBRA), according to a resolution of the Federal Government Committee, in which these rights were classified by law according to the severity of the disability attributed to workers, which ranged from severe to moderate, mild, or 'undefined' (with no right to benefits)[8].

The IFBRA allows the interviewer to assess a person's ability to complete an activity using a dependency scale and a scoring matrix that combines the International Classification of Functioning, Disability and Health (ICF) with the Functional Independence Measure (FIM). It also uses a dependency scale and accounts for help from other people, special goods, and adaptive technologies, relative to others in the same social and cultural context. This matrix design applies concepts from public health and disability studies[12-15].

The IFBRA score includes seven domains of activities and participation, comprising 41 questions (sensory, communication, mobility, personal care, home life, education and economic life, socialization, and community life), plus an additional set of four questions used in Fuzzy logic-based decision-making[16-20].

Since 2014, although it has not been validated, physicians and social workers have used the IFBRA in disability assessments for more than 17,000 PwDs requesting early retirement. There is strong demand, both from government agencies and PwDs themselves, to validate the criteria that determine severity levels used to regulate PwDs' rights to disability retirement.

The first problem was the lack of a previous standard to assess scores and determine the severity of PWDs' disabilities. The IFBRA was developed without prior knowledge of comparative studies that categorized the disability as severe, moderate, mild, or undefined[7].

This article describes how a project by the Research Group of the University of Brasília (UnB) collected national data to develop a standard reference scale and presents an accuracy analysis to determine the most effective cutoff points for IFBRA sum scores.

Material and methods

To analyze the accuracy of the IFBRA, a national cross-sectional survey was conducted using a census design[21,22]. This was the third phase of a comprehensive project to assess IFBRA validity. The first two phases evaluated construct and face validity and were described in another publication[23].

This 'Phase III' precision analysis, or quantitative validation, was conducted using official national computer registries of all legal assessments carried out and registered in Brazil

between November 2013 and January 2016. We included all records with a recorded sum score. We compared the automatic disability scores from IFBRA government records with responses to three questions added at the end of, and outside, the IFBRA matrix. Those questions assessed the severity of the disability as perceived by the interviewed PwD worker and his evaluators, a pair consisting of a physician and a social worker. This procedure is described in a separate article.

In the absence of other standards, the approach involved constructing a reference scale by collecting, examining, and measuring the opinions of the three people involved in each interview, regardless of IFBRA scores. The study group applied the common assessment area between physicians and social workers and treated their agreement on severity at the intersection as a 'platinum standard' to validate the IFBRA scale.

The study analyzed total agreement between pairs of evaluators, regardless of the summed scores of the Information and Systems Regionalization Project (PRISMA). The best agreement between the three possible pairs was observed in the pair composed of a physician and social worker, who obtained a total agreement of 49.89% in the severity assessments (Kappa index = 0.2707)[24]. We adopted the intersection agreement area of Boolean algebra as a 'platinum standard' to construct a list of three cutoff points that provided the best possible combination to balance sensitivity without losing specificity[25,26].

First, we constructed curves with at least eight different cutoff points to evaluate a common intersection point and select the most appropriate cutoff point. The second step in the sensitivity analysis was to construct graphics of the Operator Response Characteristics Curves to the Instrument (ROC) to compare sensitivity (true positive rates on the ordinates) with 1-specificity (false positive rates on the abscissas). We considered the best ROC curve to be the one with the most asymptotic design, i.e., with the largest area under the curve that included severe cases of disability and the largest area above the curve that excluded PwDs from eligibility for early retirement[25,27].

According to the sensitivity analysis, we selected three cutoff points, accounting for the requirement of four line segments for the IFBRA sum scores, to classify from severe to ineligible.

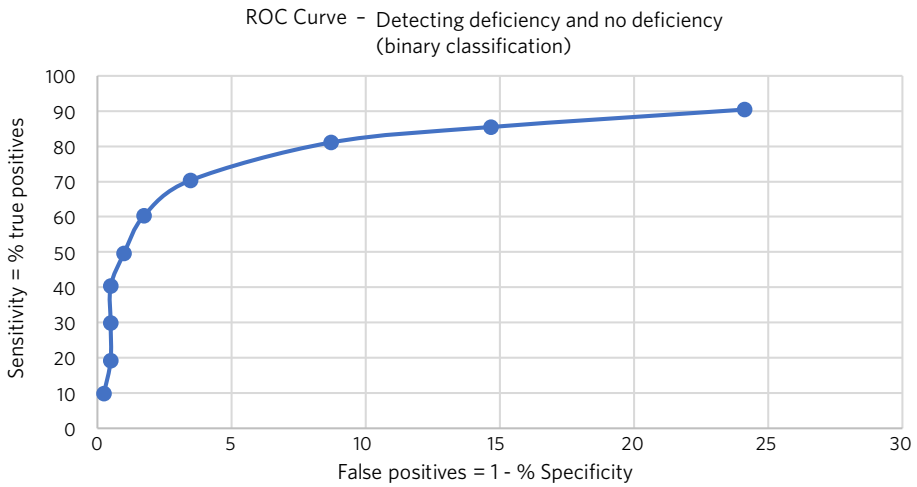
In line with the specific Brazilian legislation and the Principles of the Declaration of Helsinki, the entire project was analyzed and approved by the Internal Review Boards of the Faculty of Health Sciences of the UnB, under the Certificate of Presentation for Ethical Appreciation – CAAE No. 37058914.5.0000.0030 and Opinion No. 1.024.284. Each interviewee provided written informed consent for any material referring to themselves to be included in the study and acknowledged that they could not be identified.

Results

We retrieved a total of 17,350 complete interview records with PwD workers from across the country. The vast majority, 98.39% (n = 16,799), received only one evaluation from both professionals – physician and social worker – while a minimal proportion, 0.159% (n = 544), were interviewed twice, and only 0.002% (n = 3) were interviewed three times.

The total ability to discriminate the disability trait in the general population requesting early retirement benefits was evaluated. There was concern about the feasibility of using the IFBRA compared with evaluations by INSS experts and specialists. *Graph 1* presents the ROC curve comparing the sum of the two evaluators' scores with the standard classification of disability severity.

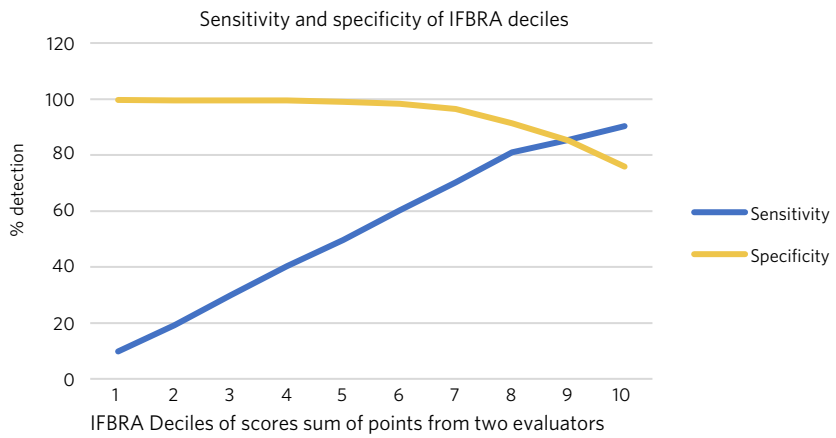
Graph 1. Curves of characteristics of Operators' Responses to the Instrument for IFBRA summation scores, considering all categories – severe, moderate and mild – as a 'platinum standard'. National Census of PwD Workers registered with the INSS, October 2013 to January 2016



Source: Prepared by the authors.

Total discrimination of disability presented a good profile, with better performance in the middle of the distance between the eighth and ninth decile. *Graph 2* shows that the point corresponding to a sum of 7,750 in the ninth decile offered a sensitivity of 85.44% and a specificity of 85.32% for better discriminating PwDs from candidates considered to have no disability trait. This value became the boundary between the classification of 'mild' PwD and people with impediments that do not characterize disability or without the right to early retirement benefits.

Graph 2. Sensitivity and specificity curves with a cutoff point of 7,750 between severe, moderate and mild disabilities versus 'no disability', using the sum of the IFBRA or 'platinum standard' scores as reference. National Census of Brazil, October 2013 to January 2016

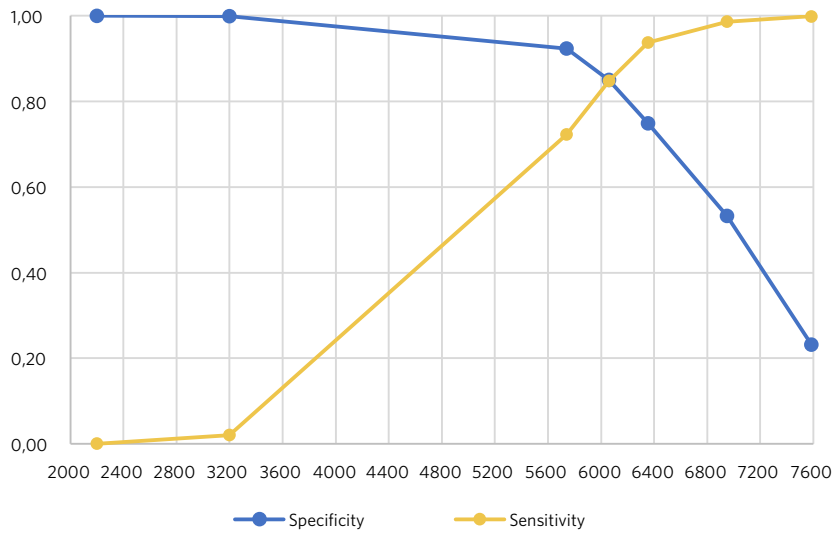


Source: Prepared by the authors.

The cut-off value of 7,750 points on the IFBRA scale seemed to balance the fairness of recognizing *versus* excluding people from the law's benefits. So, this was considered the limit for PwDs and people with minor impairments who could not be considered to have disabilities. This value became the limit between the classification of 'mild' PwDs and people with impairments who do not characterize disability or who are not entitled to early retirement benefits.

It was observed that physicians specialists recognized 'severe disability' with half the frequency of social workers. Physician-social worker pairs agreed more on classifying moderate severity than on classifying severe disability. Their shared assessment provided the best match when the sum scores were 6,060 or less, resulting in a sensitivity of 84.8% and specificity of 85% (*graph 3*).

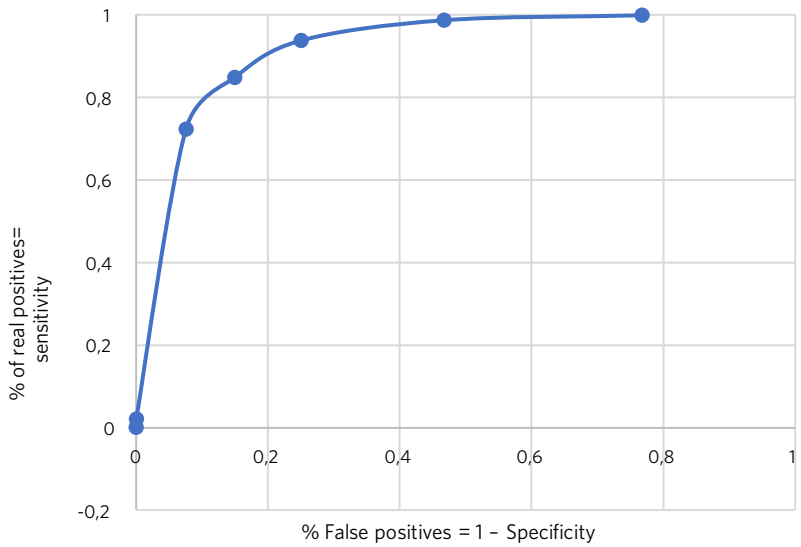
Graph 3. Sensitivity and specificity curves with a cutoff point of 6,060 between severe and moderate disabilities, using the sum of the IFBRA or 'platinum standard' scores as the reference. National Census of Brazil, October 2013 to January 2016



Source: Prepared by the authors.

Once the 'platinum standard' was assumed, we used the 17,350 observations from the national survey and performed a binary analysis to plot curves for true-positive and false-positive classification. The visual comparison demonstrates the positive performance of these operators, since most of the area is under the curve (*graph 4*).

Graph 4. Curves of Operators' Response Characteristics to the Instrument for IFBRA summation scores, considering the severe category as a 'platinum standard'. National Census of PwD Workers registered with the INSS, October 2013 to January 2016



Source: Prepared by the authors.

The same procedure allowed us to locate two additional cutoff points to separate moderate from mild (Sum of scores = 6,750; Sensitivity = 66.1; Specificity = 63.25 and mild from no right to benefits or 'undefined' (Sum of scores = 7750; Sensitivity = 14.23; Specificity = 14.56), thus obtaining three cutoff points and four line segments for the sum of the IFBRA scores.

Using this binary classification method to obtain cutoff points, we compared the original expected cutoff percentiles, previously established by the government committee for use in the INSS (PRISMA System), with the validated IFBRA cutoff points. Differences are observed in the total sum scores and in the number of people whose classification category changes (*table 1*).

Table 1. Comparison of the frequency and proportions of the disability severity classifications officially implemented (PRISMA) and after the validation process (IFBRA) of the Brazilian Census among 17,350 insured persons with disabilities, October 2013 to January 2016

		IFBRA validated categories				
		Severe	Moderate	Mild	No benefits	
Non-validated PRISMA	Category	2050 ⊦6060*	6060 ⊦6750*	6750 ⊦7750*	7750 ⊦8201	Total
		0	1	2	3	%
Severe	0	2,157	0	0	0	2,157
2050 ⊦5740*		12.43	0.00	0.00	0.00	12.43
Moderate	1	1,344	1,735	0	0	3,079
5740 ⊦6355*		7.75	10.00	0.00	0.00	17.75
Mild	2	0	2,211	6,172	0	8,383
7585 ⊦8201		0.00	12.74	35.58	0.00	48.32

Table 1. Comparison of the frequency and proportions of the disability severity classifications officially implemented (PRISMA) and after the validation process (IFBRA) of the Brazilian Census among 17,350 insured persons with disabilities, October 2013 to January 2016

		IFBRA validated categories				
		Severe	Moderate	Mild	No benefits	
Non-validated PRISMA	Category	2050 ⊦6060* 0	6060 ⊦6750* 1	6750 ⊦7750* 2	7750 ⊦8201 3	Total %
No benefits	3	0	0	920	2,811	3,731
		0.00	0.00	5.29	16.20	21.50
Total		3,501	3,946	7,092	2,811	17,350
%		20.18	22.74	40.88	16.20	100.00
Cumulative %		20.18	42.92	83.8	100.00	

Source: Prepared by the authors.

Notes: Cutoff points are marked with (*). PRISMA stands for the Information and Systems Regionalization Project.

In this population survey, severity categories can be defined as the absolute values of the sum scores of the pair of evaluators or as the distribution of percentiles. Because absolute values range from 2,050 to 8,200, the class ranges that demonstrate the best efficacy, as suggested by the ROC curves, are marked on the column labels. The table compares the validated values (columns) with the official class ranges (rows) used in the INSS National Census The computer's automatic sum of scores represents the corrected values after applying Fuzzy logic.

According to these results, the cut-off point for classifying PwD workers as 'severe' should be increased from the 12th to 20th percentile; the 'moderate' category, from the 30th to the 43rd percentile; and the cut-off point for those 'without benefits', from the 78th to the 84th percentile, as can be seen by subtracting the values in the margins of *table 1*. This characterizes a 'general shift to the right' when examining the validated correction for the three cutoff points for the IFBRA sum scores.

Discussion

It is commonly stated in applied sciences, such as biology, ecology, and epidemiology, that it is impossible to maximize gains to infinity without incurring unacceptable losses[21,22,28]. Applying this logic to the search for justice, the binary sensitivity and specificity tables, which examined a series of variable cutoff points, allowed us to determine the best cutoff points at which the associated maximum specificity limited the maximum sensitivity[27,29].

The ROC graphics with the largest area under the curve and a common sensitivity and specificity of 84.8% were considered best for determining the IFBRA summation scores. This demonstrated good statistical power, since screening tests in public health should minimize error in classifying severe disability in PwD workers and, conversely, minimize injustice by denying eligibility for social benefits when rights are guaranteed for 'non-severe' cases.

The combination of sensitivity and specificity curves produced ROC curves in which the best profile for including gains in detection followed the same criterion used to exclude PwDs from early retirement benefits.

In addition to the main concerns about the discriminant power for the binary PwD x Non-PwD condition, it is always necessary to be cautious when classifying a person as 'moderate' or 'mild', and as 'mild' or 'undefined'. These conditions have lower specificity

and sensitivity, and, in general, people may disagree with their evaluators and request another test. Discriminating between these levels is either a subtle way of perceiving and registering the social barriers that characterize the concept of disability, or implies prejudices against disability that are still present in Brazilian society.

Based on these parameters, the search for the best implementation of the IFBRA found that the best pair of evaluators was the one with the most caution, as physicians' and social workers' evaluations showed a significant discrepancy compared with those carried out by the insured PwDs themselves. Despite the initial concerns, these proved to be the best operator pairs for the IFBRA, wherever the INSS carried out its evaluation. From the epidemiological point of view, this means greater effectiveness of public policies for workers' health[12,25].

The criterion used to establish these cut-off points is recognized as the 'platinum standard', resulting from the Boolean algebraic intersection of physicians' and social workers' evaluations (MD ∩ SW). This reference reflects the naturalized social position of both professional groups relative to the examinees. It depends on the medical and social construction of disability and on interpretations of the rights enshrined in LC No. 142/2013[6].

This 'platinum standard' does not imply that the pairs of physicians and social workers were 'right' or 'wrong'. It simply means they are good pairs of operators for the IFBRA instrument, regardless of their disagreement with PwD workers over disability concepts and the social construction of their views of social and environmental barriers. The IFBRA construct mediates this disagreement by selecting specific domains and questions that redirect the evaluator's view in ways that do not necessarily align with the PwD worker's perceptions. A more in-depth analysis is needed to assess each item's discriminating and informative power, as well as the IFBRA domains.

Changing the cut-off points after validation allowed workers from across the country to be recalled for recognition of additional benefit gains; this applied to more than 4,400 (out of 17,350) examinees. All of these workers could move to the next severity level, with the most frequent change being workers originally classified as 'mild' advancing to 'moderate'. This means that 1,340 people could anticipate their retirement by ten instead of six years, while 2,210 people could anticipate their retirement by six instead of twoyears[8,9].

Limitations

We estimated that more than 300,000 people were eligible in Brazil; however, only 17,350 appeared for the assessment. There were no resources to recover a sample of non-respondents nationwide or to make the examined group more random. When analyzing all respondents, we observed that some variables were not recorded. These missing observations were attributed to registration by public agents who entered supplementary individual data that linked the INSS computers to the complete databases of official databases. Inconsistencies in typing and linking the databases were the main cause of missing observations and incomplete records. Another cause of incompleteness and inconsistency was recording answers to the personal self-assessment, which social workers were responsible for, at the end of the IFBRA assessment. Disagreements with the person evaluated may have contributed to the failure to enter the data after the interviews.

With 17,350 participants attending, there is likely survival bias among the cases registered in the PRISMA system. People with greater severity would likely attend less often, increasing the proportion of people with lower severity. This limitation is common in cross-sectional studies. Finally, the eligibility criteria require contribution time and service that people with more severe disabilities find difficult to meet.

Final considerations

According to evaluations by physicians and social workers, the official cut-off points were set to deny benefits for a wide range of disabilities, based on the intensity and quality of disability and the cumulative number of years PwDs had already contributed.

The IFBRA demonstrated high accuracy and validity according to the new reference standard. In this sense, three cut-off points are suggested for the sum of the scores and their respective percentiles: 6,060 – 20%, 6,750 – 43% and 7,750 – 84%, with the consequent possible recall of 4,400 PwD workers to guarantee their legal rights. We could not locate publications that constructed reference standards using a method similar to the one presented in this study; thus, we considered it feasible to use it in other countries.

Authorship contributions

Corrêa Filho HR (0000-0001-8056-8824)* contributed to the design of the validation methods, articulated with statistics and software engineering controls to design computer program outputs, discussion of the analysis, and writing of the original version of the manuscript. Merchan-Hamann E (0000-0001-6775-9466)* contributed to the coordination of the study, obtaining funding and budget management, discussion of the methods and analysis of the manuscript. Pereira ÉL (0000-0002-7771-1594)*, Barbosa L (0000-0003-2268-3212)* and Rodrigues DS (0000-0001-7391-1794)* contributed to the coordination of the field research, training and supervision of the field teams of the study. Souza WR (0000-0002-8915-4895)* contributed to the design of data collection techniques, study of databases, guarantee of data security and analysis of manuscript data. Höefel MGL (0000-0003-2176-5013)* contributed to the execution of field training actions throughout the country and training of the manuscript data collection teams. Silva GL (0000-0001-9650-2993)* contributed to the coordination of the quantitative distribution of the sample design, data collection planning, and analysis of the data and the manuscript. All authors contributed to the writing of the manuscript and approved the final version for submission. ■

References

1. Presidência da República (BR). [Constituição 1988]. Constituição da República Federativa do Brasil de 1988 [Internet]. Diário Oficial [da] República Federativa do Brasil, Brasília, DF. 1988 out 5 [acesso em 2026 jun 14]; Seção 1:1. Disponível em: http://www.senado.gov.br/sf/legislacao/const/

2. Presidência da República (BR). Lei nº 8.213, de 24 de julho de 1991. Dispõe sobre os Planos de Benefícios da Previdência Social e dá outras providências [Internet]. Diário Oficial da União, Brasília, DF. 1991 jul 25 [acesso em 2017 jan 31]; Seção I:14809. Disponível em: http://www.planalto.gov.br/ccivil_03/leis/L8213cons.htm

3. Presidência da República (BR), Secretaria de Direitos Humanos, Secretaria Nacional de Promoção dos Direitos da Pessoa com Deficiência. Cartilha do Censo

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2010 – Pessoas com deficiência [Internet]. Brasília, DF: SDH-PR/SNPD; 2012 [acesso em 2017 jan 31]. Disponível em: http://www.pessoacomdeficiencia.gov.br/app/sites/default/files/publicacoes/cartilha-censo-2010-pessoas-com-deficienciareduzido.pdf

4. Ministério da Fazenda (BR), Secretaria de Previdência. Aposentadoria da Pessoa com Deficiência no Brasil – 2º Boletim Quadrimestral sobre Benefícios por Incapacidade [Internet]. Brasília, DF; 2017 [acesso em 2026 jun 14]. Disponível em: https://www.gov.br/previdencia/pt-br/assuntos/previdencia-social/publicacoes-previdencia/publicacoes-sobre-previdencia-na-saude-e-seguranca-do-trabalhador/arquivos/aposentadoria-da-pessoa-com-deficiencia-no-brasil_-final-pos-cortes.pdf

5. Instituto Brasileiro de Geografia e Estatística. Censo de 2022: Brasil tem 14,4 milhões de pessoas com deficiência. Agência IBGE Notícias [Internet]. 2025 maio 23 [acesso em 2026 jun 14]; Notícias. Disponível em: https://agenciadenoticias.ibge.gov.br/agencia-noticias/2012-agencia-de-noticias/noticias/43463-censo-2022-brasil-tem-14-4-milhoes-de-pessoas-com-deficiencia

6. Atos do Poder Legislativo (BR). Lei Complementar nº 142, de 8 de maio de 2013. Regulamenta o § 1º do art. 201 da Constituição Federal, no tocante à aposentadoria da pessoa com deficiência segurada do Regime Geral de Previdência Social – RGPS. Diário Oficial da União [Internet], Brasília, DF. 2013 maio 9 [acesso em 2026 jun 14]; Edição 88; Seção I:1. Disponível em: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1&pagina=1&data=09/05/2013

7. Presidência da República (BR). Decreto nº 6.949, de 25 de agosto de 2009. Promulga a Convenção Internacional sobre os Direitos das Pessoas com Deficiência e seu Protocolo Facultativo, assinados em Nova York, em 30 de março de 2007 [Internet]. Diário Oficial da União, Brasília, DF. 2009 ago 16 [acesso em 2026 jun 14]; Seção I:3. Disponível em: http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Decreto/D6949.htm

8. Presidência da República (BR), Secretaria de Direitos Humanos. Portaria Interministerial nº 1, de 27 de janeiro de 2014. Aprova o instrumento destinado à avaliação do segurado da Previdência Social e à identificação dos graus de deficiência, bem como define impedimento de longo prazo, para os efeitos do Decreto nº 3.048, de 6 de maio de 1999. Diário Oficial da União [Internet], Brasília, DF. 2014 jan 30 [acesso em 2014 fev 5]; Edição 21; Seção I:2-6. Disponível em: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?data=30/01/2014&jornal=1&pagina=2&totalArquivos=184

9. Presidência da República (BR). Decreto 8.145, de 3 de dezembro de 2013. Altera o Regulamento da Previdência Social - RPS, aprovado pelo Decreto no 3.048, de 6 de maio de 1999, para dispor sobre a aposentadoria por tempo de contribuição e por idade da pessoa com deficiência. Diário Oficial da União [Internet], Brasília, DF. 2013 dez 3 [acesso em 2014 jan 30; Edição 234-A; Seção I;1. Disponível em: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1000&pagina=1&data=03/12/2013

10. Franzoi AC, Costa AJL, Xerez D, et al. Manual do Índice de Funcionalidade Brasileiro [Internet]. [local desconhecido]: Instituto de Estudos do Trabalho e Sociedade; 2013 [acesso em 2026 jul 13]. 98 p. Disponível em: http://www.iets.org.br/IMG/pdf/if-br_manualaplicacao_-_pesquisa_de_campo_etapa_2.2_-_meta_2_.pdf

11. Franzoi AC, Xerez DR, Blanco M, et al. Etapas da elaboração do instrumento de classificação do grau de funcionalidade de pessoas com deficiência para cidadãos brasileiros: Índice de Funcionalidade Brasileiro – IF-Br. Acta Fisiátr. 2013;20(3):164-78. DOI: https://doi.org/10.5935/0104-7795.20130028

12. World Health Organization. International classification of functioning, disability and health: ICF short version [Internet]. Geneva: WHO; 2001 [acesso em 2017 mar 1]. Disponível em: https://iris.who.int/server/api/core/bitstreams/83e1c3e0-cf9e-4063-a424-71ccc9a84ded/content

13. Riberto M, Miyazaki MH, Filho DJ, et al. Reprodutibilidade da versão brasileira da Medida de Independência Funcional. Acta Fisiátr. 2001;8(1):45-52. DOI: https://doi.org/10.5935/0104-7795.20010002

14. Riberto M, Miyazaki MH, Jucá SSH, et al. Validação da Versão Brasileira da Medida de Independência Funcional. Acta Fisiátr. 2004;11(2):72-6. DOI: https://doi.org/10.5935/0104-7795.20040003

15. World Health Organization; The World Bank. World report on disability [Internet]. Geneva: WHO; 2011 [acesso em 2017 fev 26]. Disponível em: http://www.who.int/disabilities/world_report/2011/en/

16. Barros LC, Leite MBF, Oliveira RZG, et al. Estabilidade de sistemas baseados em regras fuzzy e a função de Lyapunov. Biomatemática [Internet]. 2009 [acesso em 2017 jan 31];19(2009):1-10. Disponível em: http://www.ime.unicamp.br/~biomat/bio19.pdf

17. Cecconello M, Brandão AJV, Bassanezi RC. Sobre o ponto de inflexão em modelos de crescimento inibido com condição inicial fuzzy. Biomatemática [Internet]. 2009 [acesso em 2016 mar 30];19(2009):81-98. Disponível em: http://www.ime.unicamp.br/~biomat/bio19.pdf

18. Zadeh LA. Fuzzy sets. Inform Control. 1965;8(3):338-53. DOI: https://doi.org/10.1016/S0019-9958(65)90241-X

19. Massad E, Ortega NS, Barros L, et al. Fuzzy logic in action: Applications in epidemiology and beyond. New York: Springer; 2008.

20. Brancalioni AR, Magnago KF, Keske-Soares M. Validação de um modelo linguístico fuzzy para classificar a gravidade do desvio fonológico. Rev CEFAC. 2012;14(3):448-58. DOI: https://doi.org/10.1590/S1516-18462011005000094

21. Kelsey JL, Whittemore AS, Evans AS, et al. Methods in observational epidemiology. 2nd ed. New York: Oxford University Press; 1996. 432 p.

22. Szklö M, Javier Nieto F. Epidemiology beyond the basics. 2nd ed. Sudbury; Ontario: Jones and Bartlett Publishers, Inc.; 2007. 488 p.

23. Corrêa Filho HR, Merchan-Hamann E, Pereira ÉL, et al. Validação da escala de gravidade do IFBRA entre Pessoas com Deficiência no seguro social brasileiro. Saúde Debate. 2026;50(149):e10875. DOI: https://doi.org/10.1590/2358-2898202614910875P

24. Fleiss JL. Statistical methods for rates and proportions. 2nd ed. New York; Toronto: John Wiley & Sons; 1981. 321 p.

25. Fletcher RH, Fletcher SW, Wagner EH. Epidemiologia clínica. Porto Alegre: Artes Médicas Sul Ltda.; 1989. 312 p.

26. Gordis L. Epidemiology. Philadelphia, PA: W.B. Saunders Co.; 2009. 277 p.

27. Sackett DL, Haynes RB, Guyatt GH, et al. Clinical epidemiology: A basic science for clinical evidence. 2nd ed. Boston; Toronto; London: Littel, Brown and Company; 1991. 441 p.

28. Meinert CL, Tonascia S. Clinical trials: design, conduct, and analysis. New York, NY: Oxford University Press; 1986. 469 p.

29. Reichenheim ME, Hasselmann MH. Minimizando perdas e maximizando eficiência na detecção de casos de desnutrição aguda severa. Rev Saúde Pública. 2001;35(1):60-5. DOI: https://doi.org/10.1590/S0034-89102001000100009

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